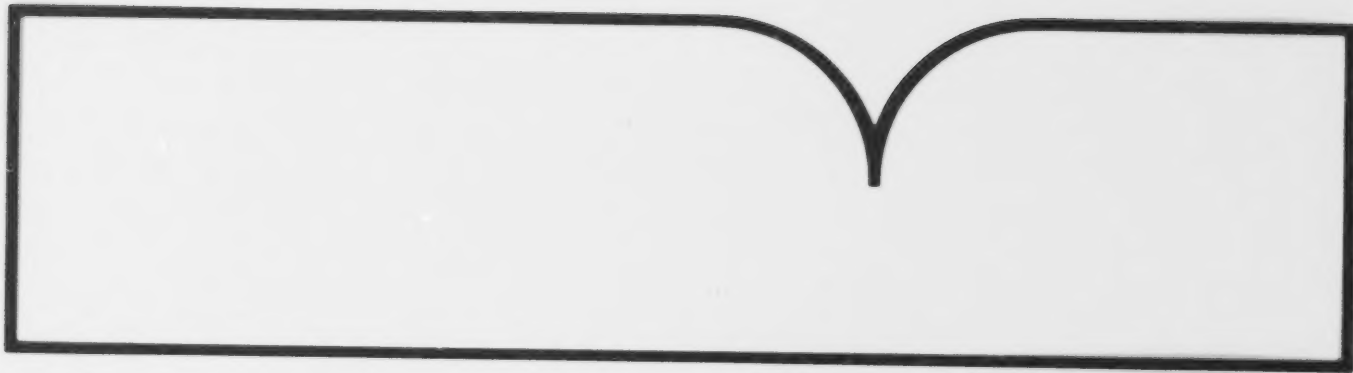


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HAZARDOUS WASTE LANDFILL RESEARCH

U.S.E.P.A. PROGRAM

Norbert B. Schomaker

Hazardous Waste Engineering Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

HAZARDOUS WASTE ENGINEERING RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OH 45268

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16. ABSTRACT The Hazardous Waste Engineering Research Laboratory (HWERL), U.S. Environmental Protection Agency, in Cincinnati, Ohio, has responsibility for research in solid and hazardous waste management with respect to land disposal of wastes. To fulfill this responsibility, the LPCD is developing concepts and is documenting the environmental effects of various waste disposal practices; and is collecting data necessary to support implementation of disposal guidelines mandated by the Hazardous and Solid Waste Amendments of 1984 (HSWA). This paper will present an overview of the land disposal research associated with the LPCD hazardous waste program plan and will report the current status of work in the following categorical areas: A. Hazardous Waste Facilities - Landfills and Surface Impoundments 1. Cover Systems 2. Waste Leaching/Modification 3. Flexible Membrane Liners 4. Clay Soil Liners 5. Quality Assurance/Quality Control 6. Expert Systems 7. Corrective Action B. Non-Hazardous Waste Facilities C. Technology Transfer		
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INTRODUCTION

The Land Pollution Control Division (LPCD), Hazardous Waste Environmental Research Laboratory (HWERL), U.S. Environmental Protection Agency (USEPA), in Cincinnati, Ohio, has responsibility for research in solid and hazardous waste management with respect to land disposal of wastes. To fulfill this responsibility, the LPCD is developing concepts and technology for new and improved control systems for solid and hazardous waste land disposal; is documenting the environmental effects of various waste disposal practices; and is collecting data necessary to support implementation of disposal guidelines mandated by the Hazardous and Solid Waste Amendments of 1984 (HSWA). This paper will present an overview of the land disposal research associated with the LPCD hazardous waste program plan.

The performance of treatment, storage, and disposal facilities is being improved to contain the complex wastes being generated by a changing society. These improvements are brought about by the development of control technologies which are useful to the USEPA program offices, Office of Solid Waste (OSW) and Regions, state and local agencies, design engineers and waste management facility operators. The results of these improved control technologies will be the ability to optimize designs, minimize maintenance and overall costs while maintaining a high degree of confidence that the waste management facility will operate as designed. The control technologies being developed or improved take into account region uniqueness, complex waste streams including quality, quantity, and physical state, and a variety of potential designs which will minimize/prevent releases to the environment from waste disposal facilities. These technologies are being laboratory-studied and field-verified to provide the user community with economical, long-lasting systems that will contain the changing waste streams that are being disposed of by traditional, innovative, and high technology industries.

This paper will present an overview of the land disposal research associated with the LPCD hazardous waste program plan and will report the current status of work in the following categorical areas:

A. HAZARDOUS WASTE FACILITIES - LANDFILLS AND SURFACE IMPOUNDMENTS

1. Cover Systems
2. Waste Leaching/Modification
3. Flexible Membrane Liners
4. Clay Soil Liners
5. Quality Assurance/Quality Construction
6. Expert Systems
7. Corrective Action

B. NON-HAZARDOUS WASTE FACILITIES

Subtitle "D" Facilities

C. TECHNOLOGY TRANSFER

Technical Resource Documents

HAZARDOUS WASTE FACILITIES - LANDFILLS AND SURFACE IMPOUNDMENTS

1. Cover Systems

The objective of this activity is to develop and evaluate the effectiveness of various cover systems in relation to their functional requirements for actual field application. The primary functional requirements are to minimize moisture infiltration and to promote gas venting. Validation efforts are being performed in the laboratory and field with model work development being pursued for eventual incorporation into a Technical Resource Document (TRD).

The initial laboratory efforts on the study of landfill cover performance have been completed. These recently completed efforts focused on multi-layered cover systems utilizing materials such as a variety of soils, flexible membrane liners and sand drainage blankets. Additional studies may become necessary depending on the results obtained from current field and modeling investigations.

The field efforts being investigated are concerned with the verification of landfill cover system construction to provide hydrologic isolation and alternative to soils for use as cover systems. The verification of landfill cover systems construction will monitor precipitation runoff and percolation through three simulated landfill covers. The alternative to soils for use as cover systems will be evaluating the effectiveness of paper mill sludge as the barrier layer in a landfill cover.

Technical Resource Documents on cover systems are a compilation of best available technology and information on methods to control infiltration, by improving long-term cover performance and development of construction, maintenance, and inspection criteria to improve clay and flexible membrane cover performance, cover drainage and maintenance free vegetative cover

systems. The initial TRD entitled, "Design, Construction, and Maintenance Cover Systems for Hazardous Waste" was published in 1984. This document can be ordered from the National Technical Information Service (NTIS). The NTIS stock number is PB81-166-340. This TRD is currently being updated and should be available for publication in the spring of 1987. A technical handbook entitled, "Covers for Uncontrolled Hazardous Waste Sites" EPA/540/2-85/002 dated September 1985 has been published under the Superfund program. This technical handbook provides guidance for regulatory personnel involved with Superfund sites but also could be used at other controlled sites.

2. Waste Leaching/Modification

The objective of this activity is twofold: (1) to develop and evaluate laboratory techniques for working with a sample of a waste or a mixture of waste to predict the composition of actual leachates obtained under field conditions and (2) to evaluate the effectiveness of solidification/stabilization and encapsulation processes for improved handling, surface area reduction, limiting solubility, detoxifying pollutants and predicting performance with time. Results from laboratory and model predictions are being compared with results from pilot-scale and field-scale work to develop better evaluation procedures and an up-dated TRD on waste leaching and waste modification.

Current laboratory efforts in relation to waste modification include the study of solidification/stabilization mechanisms, due either to physical entrapment or chemical interaction and the evaluation of special problems in polymer and physical chemistry. The study of solidification/stabilization mechanisms will determine in what phase(s) of the binder-waste matrix the contaminants are held. Microscopy and leaching procedures are being used with organic and inorganic wastes. In addition, various solidification/stabilization processes will be assessed and evaluated to determine the

effects of interfering materials (organic and inorganics) on process and product performance. Evaluation of the waste modification techniques includes leaching to determine concentrations of contaminants released and physical measurements, e.g., freeze-thaw or wet-dry, to assess durability of the solidification waste. The evaluation of special problems in polymer and physical chemistry will assess the use of polymer amended solidification and stabilization processes for possible establishing BDAT requirements specified under the Hazardous and Solid Waste Act (HSWA) legislation. In addition, the physical and chemical characteristics of the polymer solidified waste will be evaluated. The effects of hazardous waste on polymers and polymer reactions will be examined to establish durability and lifetime data on flexible membrane liners (FML's) and polymer encapsulated waste.

Future field efforts may become necessary depending on results obtained from present laboratory investigations as there are no field studies currently in progress.

The original TRD on "Solid Waste Leaching Procedure" (SW-924) has been updated and a second edition entitled, "A Procedure for Estimating Monofilled Solid Waste Leachate Composition" (SW-924) is being reviewed by the EPA's Office of Solid Waste (OSW). Final publication is expected by March 1987. In addition to the leaching procedure TRD, a TRD entitled, "Landfill and Surface Impoundment Performance Evaluation" (SW-869) relating to leachate generation was published in 1984 and can be obtained from NTIS; PB81-166-357 is the NTIS stock number. The original TRD, "Guide to the Disposal of Chemically Stabilized and Solidified Wastes" (SW-872), was published in 1984 and can be ordered from NTIS; the NTIS stock number is PB81-166-505.

This original stabilization TRD has been updated in a technical handbook for Superfund sites. This document, "Handbook for Stabilization/ Solidification of Hazardous Wastes," EPA/540/2-86/001, dated June 1986, has been published.

ification of Hazardous Wastes," EPA/540/2-86/001, dated June 1986, has been published.

3. Flexible Membrane Liners

The objectives of this activity are to evaluate the effectiveness of synthetic membranes or flexible membrane liners (FML's) as liners and surface caps to contain or minimize leachate movement and prevent moisture infiltration, and to develop means by which the long-term performance of liners can be predicted.

Laboratory efforts include the evaluation of upward hydrostatic forces on FML's and loading points and also FML reliability methodology development. The research of upward hydrostatic forces on FML's and loading points will be evaluating the puncturability effects of fixed point loads in a subgrade under slowly increasing downward water pressure. Room and elevated temperatures are being used to accelerate the potential reaction. The benefits of using geotextiles to improve liner performance will also be evaluated. FML reliability methodology development will examine and integrate all the factors that will effect performance and service life of a FML. The output will be estimates of reliability with associated degrees of confidence regarding failure (leaks), failure types, and when they might be expected to occur.

The effort to develop field verification data for FML's has met with limited success. Results indicate laboratory tests, such as Method 9090, can predict the chemical compatibility of FML's. However, additional field data are required to assess long-term performance and environmental stress cracking.

A major revision of the TRD, "Lining of Waste Impoundments and Disposal Facilities" (SW-870), is underway. New information is now available on

improved techniques for estimating chemical compatibility, seam quality, and understanding field failure mechanisms. The very rapid increase in use of geotextiles and geonets in lining systems necessitates a major revision to the TRD to include these topics. The TRD draft revision is scheduled for the fall of 1987 with final publication anticipated in early 1988.

4. Clay Soil Liners

The objective of this activity is to evaluate the effectiveness of compacted clay soils used in surface covers and bottom liners for minimizing infiltration of water and escape of leachate. Results of these laboratory and field evaluations are then used to develop procedures for evaluating designs and predicting long-term performance so that liners can be constructed to perform in accordance with design specifications.

Laboratory efforts are evaluating the effects of organic chemicals on the structure and permeability of clay soils compacted to soil liner specifications and the determination of effective porosity of soil materials. All the concentrated solvents examined increase the permeability when tested with soils of several different dominant mineralogical composition. Where solvents have been diluted with water, in short term laboratory hydraulic conductivity tests, there has been no adverse effect shown on clay soil permeability until the diluted mixture is predominantly solvent in composition. Permeability tests using actual landfill leachate solutions similarly have so far not been shown to adversely affect permeability. The critical concentration at which a solute will begin to affect soil permeability varies with each solute or co-mixed solvent, and generally has not been well documented for most chemical compounds. Inorganic solutes are also being examined in laboratory permeability tests. As with the case of organic solvents, where relatively dilute concentrations have been tested,

no adverse effect on soil permeability has been seen. Our most recent studies are examining highly concentrated inorganic salt solutions.

The potential for obtaining accurate laboratory measurements of effective porosity in compacted clay soil liner materials is being studied in projects directed toward both surficial native soils and deeper geologic deposits. Effective porosity--the fraction of the soil pores active in leachate transport--is a significant factor in the relationship used to calculate solute travel time through a porous media. Lower fractions of effective porosity lead rapidly to shorter solute migration times through a fixed volume or distance. Data show that morphometric methods--characterizing pore size and geometry by measurement in thin sections of small masses of the compacted soil--are quite complex, and need substantial further refinement. Use of solute tracer breakthrough curves acquired in parallel with classical permeability data appear to be the most practical current approach. Although the interpretation of curves generated by laboratory studies is still at a very young stage. Effective porosity that is dominated by open fractures or fissures in the compacted soil liner appears to be the major flow pathway in field-scale studies. The prevalence and size of these flow pathways, however, is difficult to quantify and evaluate.

Field studies are comparing laboratory permeability values with the actual hydraulic conductivity of the same soil compacted with full scale construction equipment and examining the actual transit time of a tracer solute through a compacted soil liner. Laboratory permeability data obtained, depending upon where, on an area basis, samples are taken and tested. The actual transit time of a tracer solute through a compacted soil liner is being examined and is showing that actual solute breakthrough is earlier than predicted by laboratory tests using the same soil material. Optimizing soil liner construction to achieve the lowest permeability possible on a

field scale is addressing controllable factors such as soil moisture content, equipment selection, and equipment usage. Recent results demonstrate the difficulty encountered when structural soil criteria are used to govern soil liner construction where higher than optimum moisture content and unusual construction equipment operation are involved.

Technical Resource Documents have been developed to collect and analyze information on design, construction, and evaluation of clay liners and information on the use of batch adsorption procedures to design clay liners for pollutant removal. These TRD's have been published for public comment with revised versions forthcoming.

5. Quality Assurance/Quality Control (QA/QC)

QA/QC has become an area of increasing importance and emphasis in the design and construction of land disposal facilities. It is a critical element in the fabrication of materials, e.g., FML's and drainage nets, design and construction of system components, e.g., covers, clay and FML liners, and drain systems, and the physical construction of the disposal facility. Implementation and adherence to a strong QA/QC plan are among the major factors in assuring that land disposal facilities successfully perform as designed.

This program area has been addressed indirectly in several previous projects dealing with soil liner hydraulic conductivity measurements, FML seaming and inspection requirements, subsurface preparation, liner bedding requirements, and similar activities. The first project to address this area directly was the preparation of a technical guidance document entitled, "Construction Quality Assurance for Hazardous Waste Land Disposal Facilities," EPA/530/SW/85/021, which presents summaries of state-of-the-art technologies and evaluation technologies determined to constitute good engineering

designs, practices, and procedures. Upon publication in late 1986, it will support the Resource Conservation and Recovery Act (RCRA) TRD's and Permit Guidance Manuals by describing current technologies and methods for designing hazardous waste facilities and for evaluating the performance of the facility design. The document discusses QA/QC requirements in foundations, dikes, low permeability soil liners, flexible membrane liners, leachate collection systems, and final cover systems.

This area of research is continuing in FY'87 with activities designed to identify the factors critical in the proper construction of a clay liner. Such factors as soil moisture, clod size, thickness, equipment type, once identified, will be applied and evaluated using field scale test liners. The data will help optimize the construction of clay liners. Concurrent studies will be conducted to evaluate several methods for determining true hydraulic conductivity, morphology of the compacted liner, sampling requirements, and other factors important in evaluating liner design and performance. Another effort will address the spatial relationships and frequency of sampling points required in the clay liner to predict final performance.

Because QA/QC is a complex area, the research continuing in FY'87 will proceed at a deliberate and reasonable pace. HWERL will keep abreast of QA/QC activities being performed by other research organizations so as additional information becomes available on sampling requirements and factors critical in fabrication and construction of facilities it can be added to the guidance document.

6. Expert Systems

The objective of this activity is to develop user-friendly, computer-based systems that will assist the permit writer in evaluating a permit for treatment, storage and disposal facilities. These systems will emulate the

the heuristic rules they use to arrive at a particular decision in their specialized area.

Laboratory efforts are examining the development of automated systems to assist in decisions concerning hazardous waste facilities and the feasibility of using expert systems for determining liner/waste chemical compatibility. To facilitate timely development of permit review systems, the review process for land disposal and storage facilities has been partitioned into discrete decision areas. An independent system is being, or will be, developed for each of the high priority decision areas. Systems are currently being developed to assist in evaluation of the chemical resistance of flexible membrane liners, safety analysis of surface impoundments, waste analysis plans, closure plans, leachate collection systems, and surface runoff controls. Some of these systems are being tested in preparation for distribution to the permit reviewers whereas some will not be available for testing until summer of 1986. All of the systems are being developed for implementation of the EPA standard IBM's PC AT microcomputers.

A system is also being developed to assist in screening of control technologies for CERCLA sites. Other CERCLA related decision areas that would be amenable to expert system application are currently being explored.

The TRD developed in this area, EPA/530/SW/84/009/10 "The Hydrologic Evaluation of Landfill Performance (HELP) Model," is being updated to incorporate the two-dimensional aspects of landfill cover systems and recently acquired field data. The field data is being used to calibrate and refine the model. Final publication of these documents is expected in late 1987.

7. Corrective Action

Corrective action is required to clean up releases from land disposal sites that have adversely affected groundwater. The applicable technologies

7. Corrective Action

Corrective action is required to clean up releases from land disposal sites that have adversely affected groundwater. The applicable technologies would be similar to those in use at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites where subsurface water has been contaminated. Although described as repairs or maintenance, corrective actions are also required in other parts of the regulations. Emergency repairs of covers, liners, and leachate systems during the active life of a disposal site are required by all treatment, storage, and disposal facilities.

Corrective action will involve identifying problems at waste disposal units that cause releases to the environment and applying engineering and management methods to correct the problems. Procedural and technological issues under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) program are documented in a number of handbooks and technical guidance documents. Activities are being anticipated to evaluate corrective actions under the CERCLA program for application to Subtitle "C" hazardous waste facilities and the Subtitle "D" non-hazardous waste facilities. HWERL will follow closely OSW efforts to set up procedures for determining releases of pollutants from RCRA facilities in an effort to develop guidance in setting up assessments, and to initiate needed assessments.

NON-HAZARDOUS WASTE FACILITIES

Subtitle "D" Facilities

The objectives of this activity are to characterize wastes, leachates, and air emissions from municipal solid waste (non-hazardous) processing and disposal facilities and from large-volume waste disposal facilities, and assess control methods. This research is being conducted to support legislative requirements of HSWA that the Agency review and modify, if necessary,

the current criteria being used to manage non-hazardous municipal, commercial, and mining wastes (Subtitle "D").

Laboratory studies include the exploration of chemical and biological methods for rapid stabilization of municipal solid waste sites in an attempt to render them and their leachates inactive or less harmful to the environment. Recirculation, soil filters, and other methods of treatment are being investigated in conjunction with stabilization methods. Experimentation with the control of methane from municipal solid waste by lime injection is being conducted to measure the gas production rates and quantities, to measure leachate volumes and composition, and to compare the lime treated gas generation to previous results from untreated simulators.

Modeling efforts include the development of an improved model for predicting leachate quantity and quality and the use of previously developed models predicting gas migration in order to design gas controls and to develop general gas control design guidance.

Current field studies are identifying the types of problems that occur at Subtitle "D" facilities, review current practices for dealing with problems, and suggest potential technologies for correcting problems. Detailed chemical analyses of liquid phases of municipal landfill gas condensate are being performed to determine if these different liquid phases have any hazardous waste characteristics. Samples are also being taken of ash residuals from actual municipal waste combustion facilities. These residuals are being analyzed to determine their levels of hazardous constituents.

TECHNOLOGY TRANSFER

Technical Research Documents

Technology transfer encompasses the collection, documentation, and dissemination of scientific and technical information, including (a), data on the performance and costs of using the technology, (b), the transformation of research and technology into processes, products, and services that can be applied to public or private needs, and (c), the secondary application of research or technology developed for a particular mission that fills a need in another environment.

Regional, state and local agencies are responsible for implementing remedial action programs for uncontrolled hazardous waste sites and corrective action programs for permitted RCRA facilities. As the responsibility for technical and administrative activities shifts from EPA headquarters to the EPA regions and states, specific Agency guidance in many areas will become necessary. Many states must now perform technical evaluations and administrative enforcement actions associated with cleanup programs. States must now write permits, perform inspections, and take necessary enforcement actions to ensure that individual pollution sources comply with national standards. States must also take the lead in the design and construction of remedial actions. Many new and relatively inexperienced people are involved in the administration and technical evaluation of existing permitted RCRA facilities. EPA must apply its critical mass of central resources to conduct research, to develop tools for use in the field, and to provide technical support where needed to avoid wasteful, duplicative investments by the states. A need exists to separate the engineering guidance that is directly useful to regulators, enforcement personnel, and private industries from research findings and other technologies not yet applied in practice. Programs must be developed that provide a complete multimedia package of

technical, economic, and regulatory information. Also, special publications are needed to extract the essential technical and economic information needed by managers and to emphasize final results effectively.